# Fluctuating the Speckle is detected by 'Hinode' XRT according to solar activity

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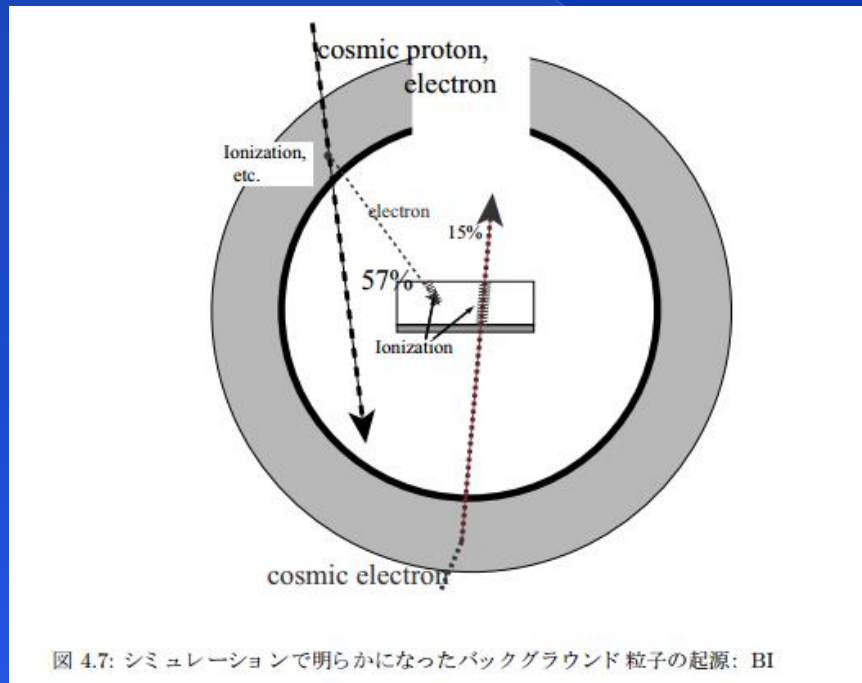
Solar Energetic Particle and Space Weather

- Flare and CME generate SEPs.
  - › SEPs generate "false" signal on the CCD image.
    - • This study calls Speckle.

- Cause is secondary particles generated by collision with shield of SEPs.
  - › Speckle becomes indication of how many SEPs flew on the satellite orbit .

HINODE XRT JAXA/ISAS, SIRIUS 7-Mar-2012 12:05:09.008 UT
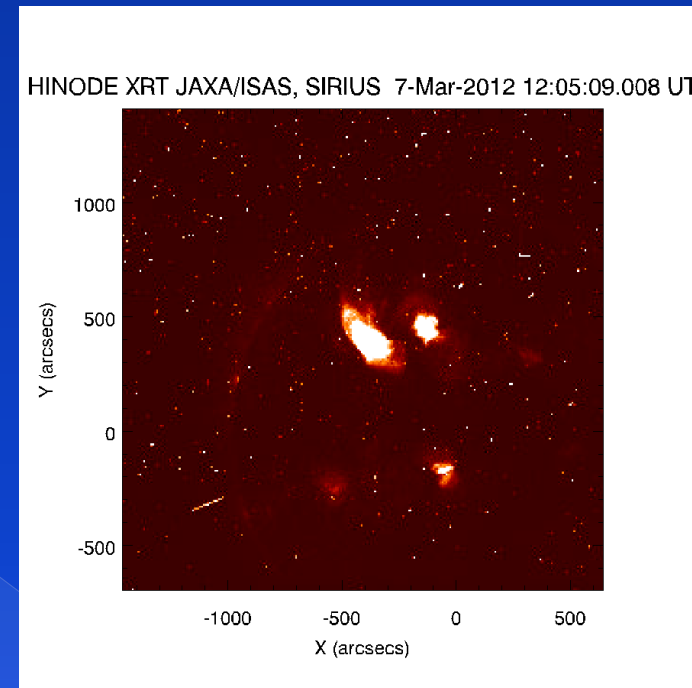
Hinode / XRT
2012 / 03 / 07 UT

Cause of speckle

図 4.7: シミュレーションで明らかになったバックグラウンド粒子の起源: BI

Quote from Master thesis
Katou 2007

I. High energy particle collisions to shield.

II. Electron generation occurs.

III. The collision in CCD.

I. High energy particle collisions in CCD.

Purpose

- SEP will cause a lot of space weather damage.
  - However, quantitative model of the SEP is not complete .

- For the character clarification of the SEP , it will focus on the CCD noise .

- Performs detection analysis of the Speckle using satellite data, to identify the cause of the variation.
  - It will continue to clarify the conditions to be observed .
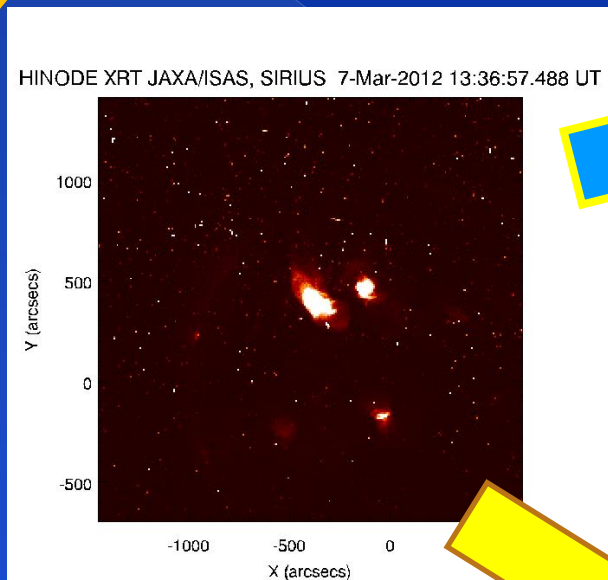
Observation equipment Using data

- ◉ Used equipment
  - › Hinode / X – Ray Telescope (XRT)
- ◉ Orbit
  - › Sun-synchronous polar orbit
    - • Altitude 680 km
- ◉ Used data
  - › Flare time patrol image
  - › Image size : 256×256 pix
  - › Time resolution : 30 sec
  - › Used filter : Ti_poly
  - › Exposure time : 8.8msec(Ave.)
- ◉ Analysis object
  - › Solar proton event

HINODE | SOLAR-B

DE XRT JAXA/ISAS, SIRIUS 7-Mar-2012 13:23:47.72
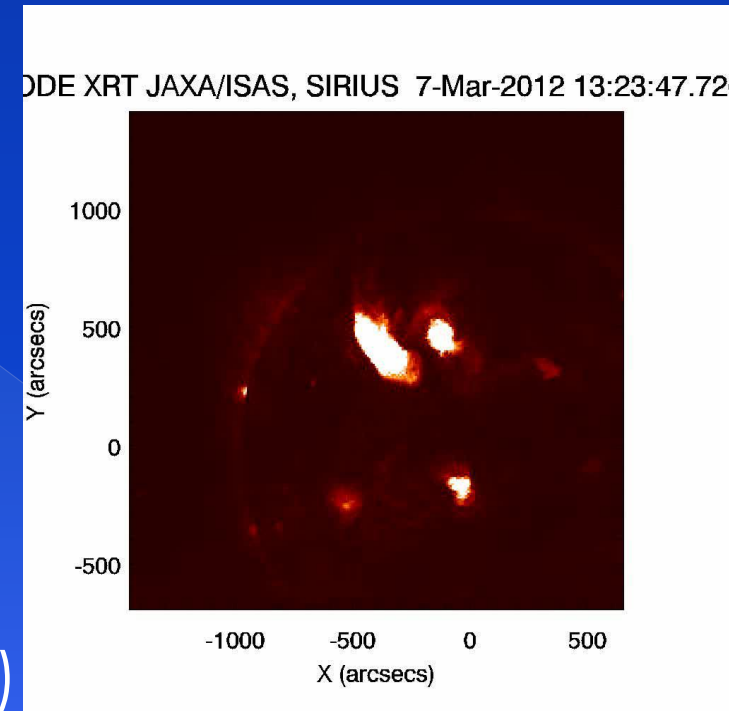
Hinode / XRT
7th Mar. 2012
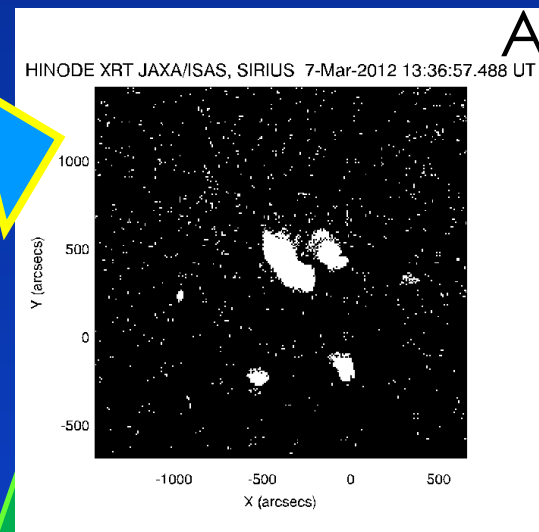
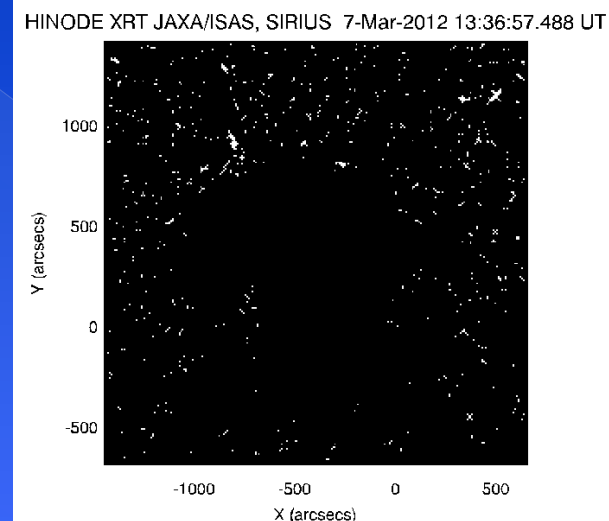# Image processing

Binarization of single image

Subtract B from A

Emphasize speckles of row data.

Binarization of superimposed images.
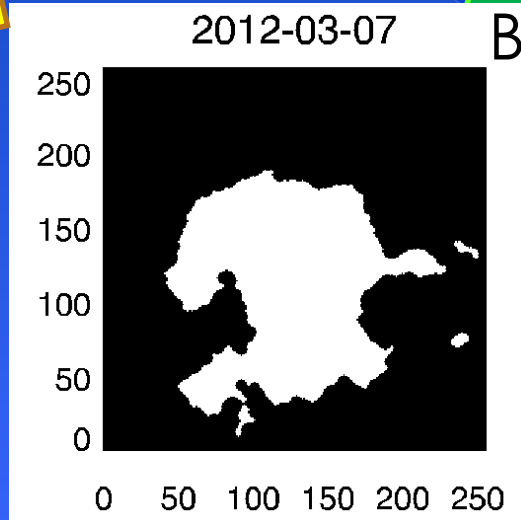
Character of speckle in Hinode / XRT

HINODE XRT JAXA/ISAS, SIRIUS 7-Mar-2012 13:36:57.488 UT
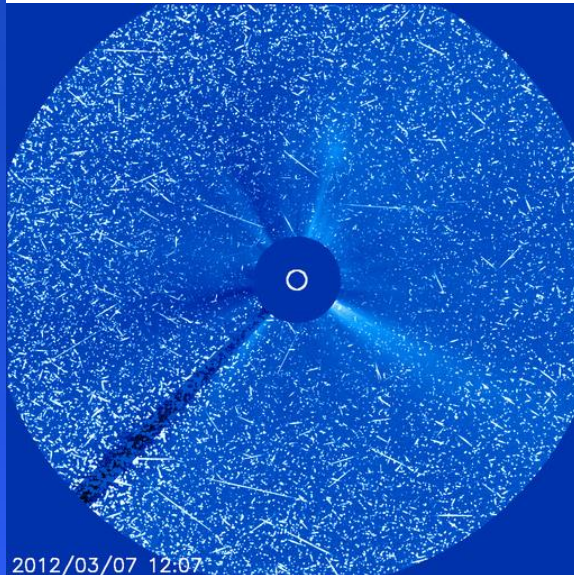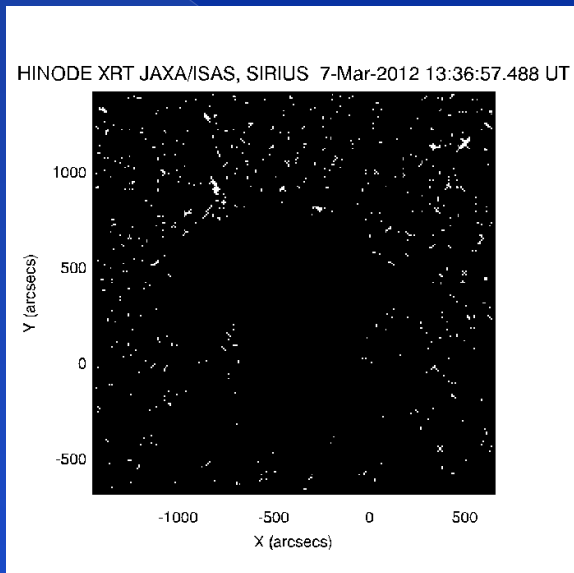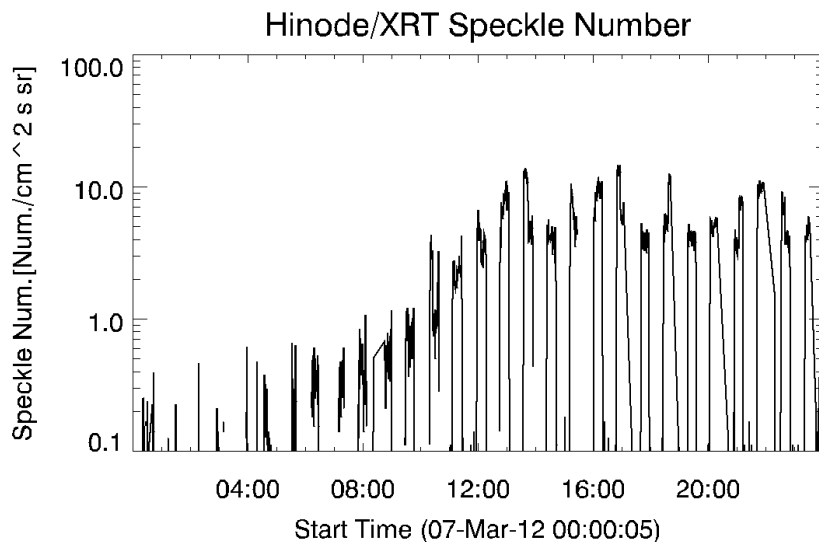
2012/03/07 12:07
SOHO / LASCO (C3)
7th Mar. 2012

- ◉ Speckle size is small and short than SOHO/LASCO's it .

- ◉ CCD camera of the XRT is made Si.
  - › The energy required to produce the Speckle could be estimated to about 50keV per pixel .

 - › I continue calculated the energy of the particles at the time of collision.

Time variation of detected number of speckles

GOES 15 X-Rays:

— GOES X-Ray intensity
◇ Speckle Number

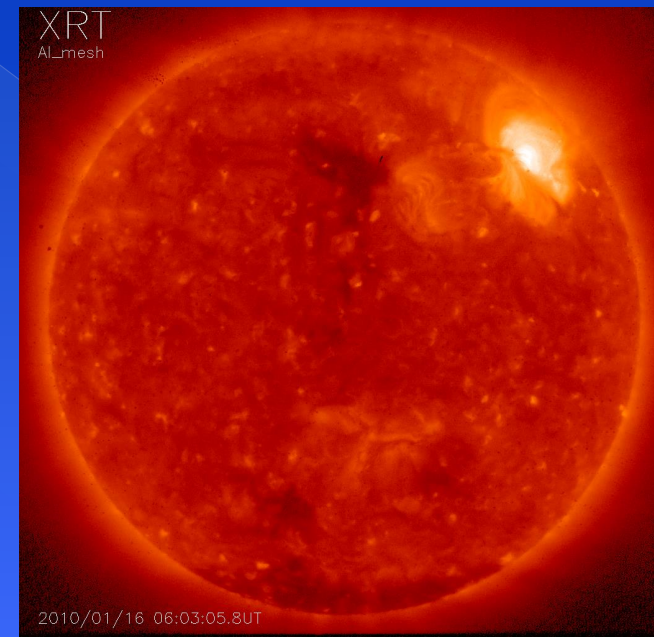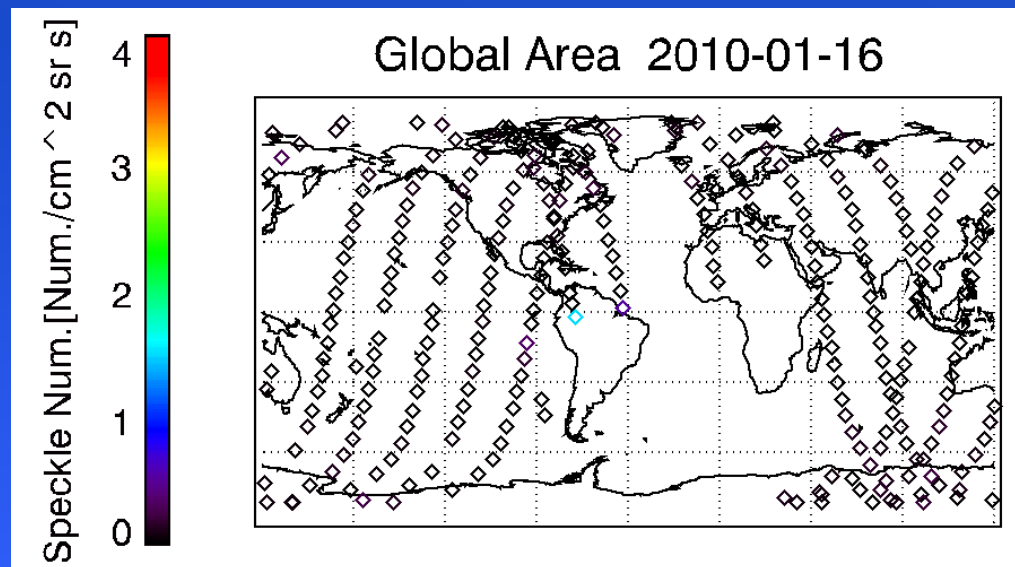X1.3
X5.4

Hinode/XRT Speckle Number
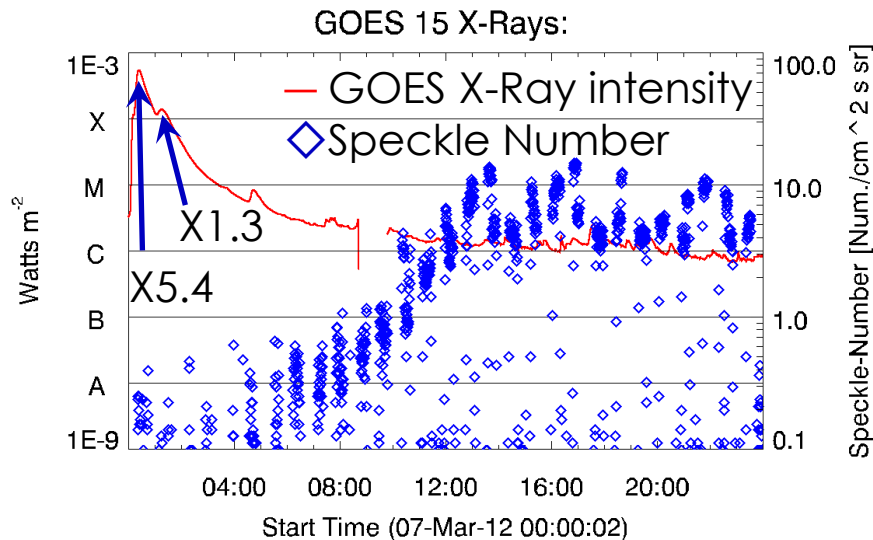
- Analysis results of 7th Mar. 2012.

- X5.4 and X1.3 Flare occurred 0:02 and 1:05 UT.

- After flares occur , speckles increase after a few hours.

- There is a cycle in the increase or decrease of the speckles.
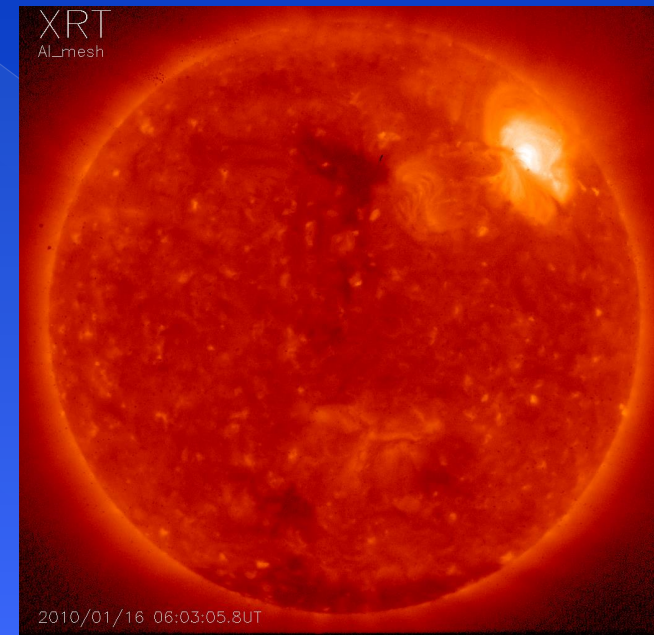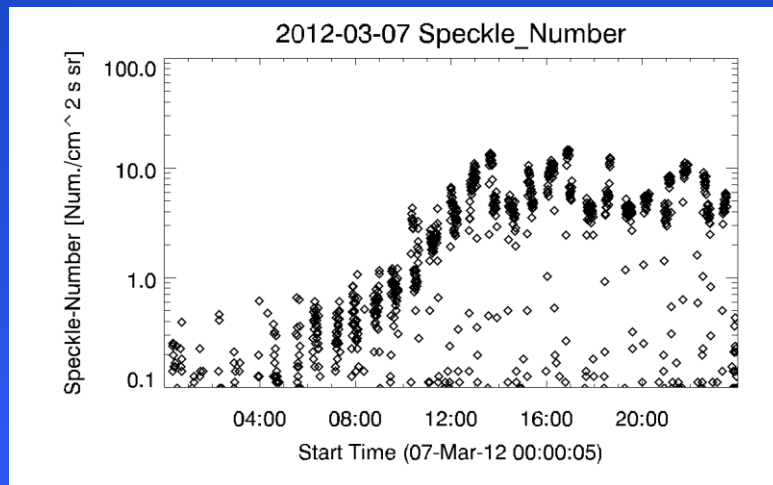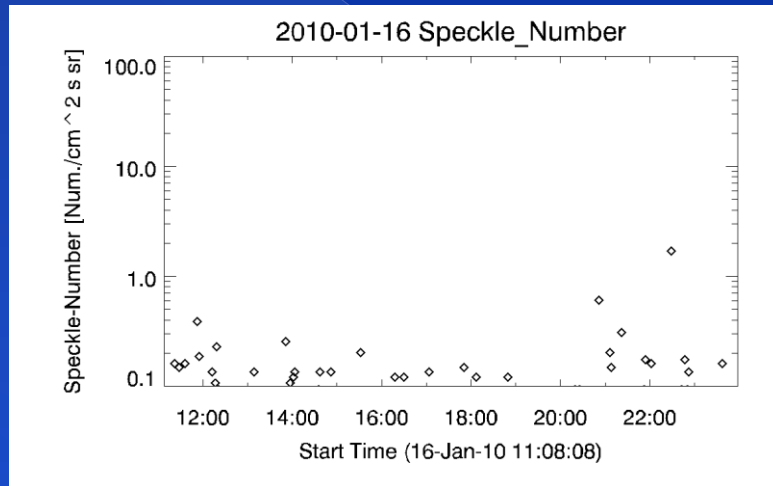
Consideration for background
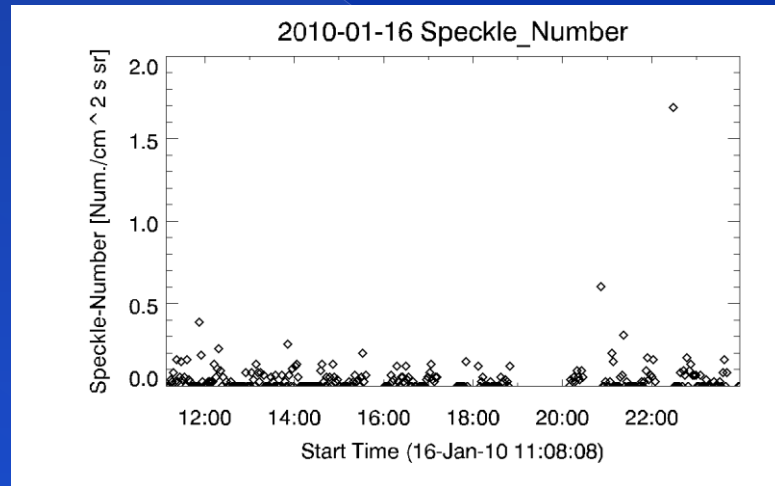
2010-01-16 Speckle_Number

Global Area 2010-01-16

- Analyzed data for 16th Jan. 2010 .
  - AR are less .
  - Large flare and CME didn't occur .
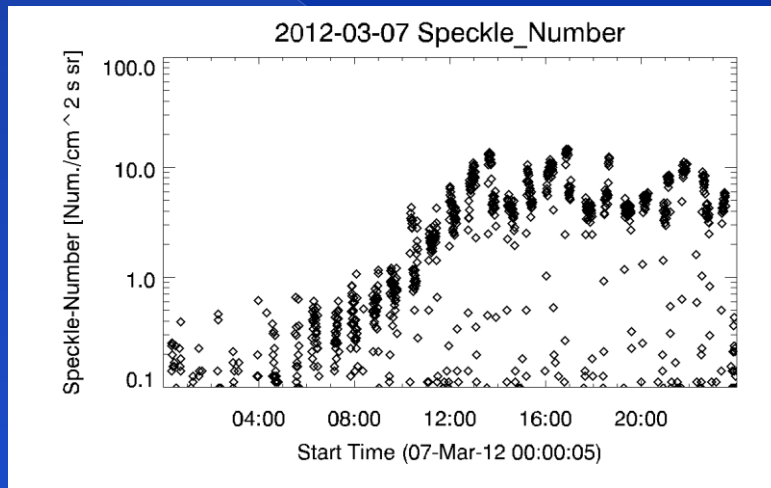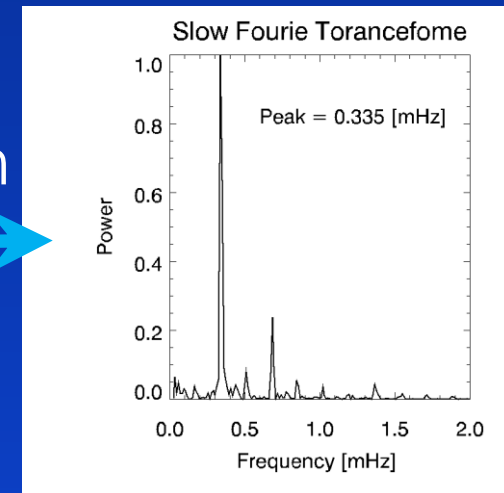 - $Med.BG_{speckle} = 0.013$

Consideration for background

- Analyzed data for 16th Jan. 2010 .
  - › AR are less .
  - › Large flare and CME didn't occur .
  - › $Med.BG_{speckle} = 0.013$

Periodicity of speckle number

2012-03-07 Speckle_Number

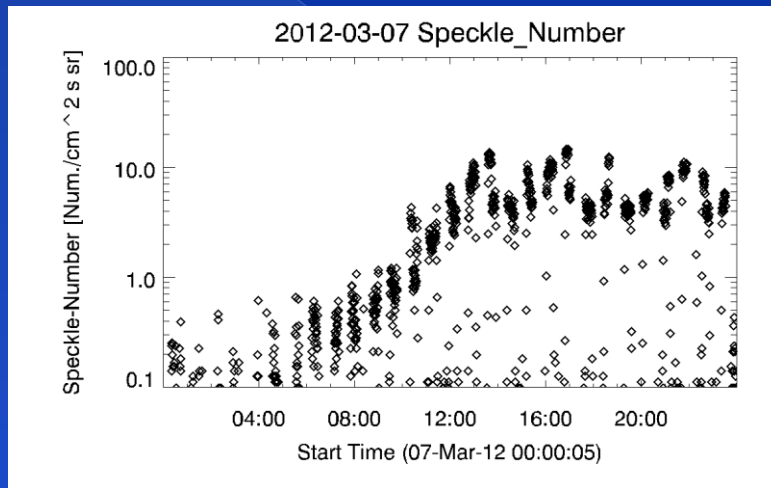Fourier transform

Slow Fourie Torancefome

Peak = 0.335 [mHz]

- Detection number increased in certain timing .
  › There is an increase of decrease in a particular location .

Hinode Orbital period	5900 [sec]
Speckle Detection cycle F = 0.335	2980 [sec]

Periodicity of speckle number

2012-03-07 Speckle_Number

Magnetic pole

Nor. Hem. 2012-03-07
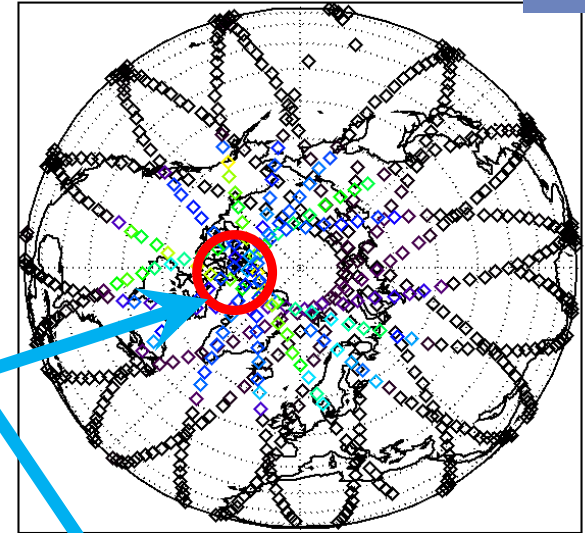
Sou. Hem. 2012-03-07

Speckle Num.[Num./cm^2 sr s]

- Speckle has been found to increase in the polar region in orbit .

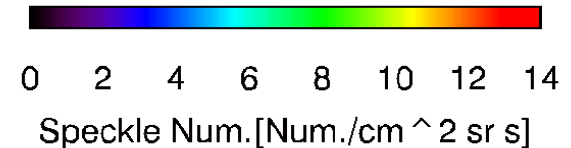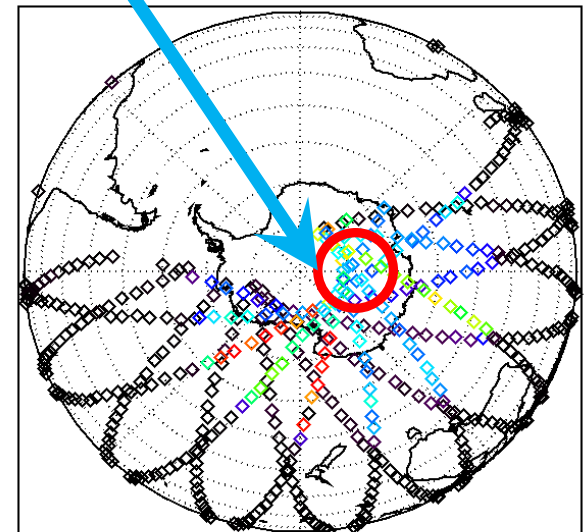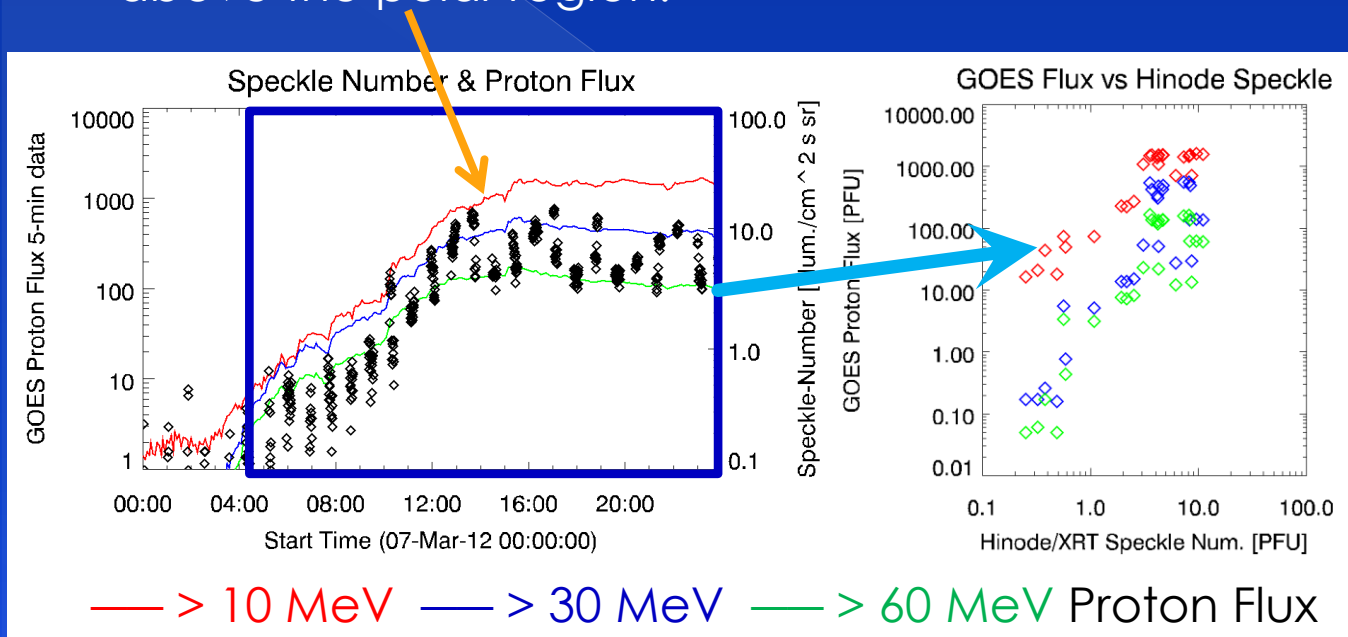- It increased at 60 degrees or more from latitude 55 degrees is happening .

Comparison GOES Proton Flux

During the Hinode moving above the polar region.

— > 10 MeV   — > 30 MeV   — > 60 MeV Proton Flux

X5.4 UT 0:02
X1.3 UT 1:05

2012 / 03 / 07	Correlation factor
> 10 MeV	0.92
> 30 MeV	0.89
> 60 MeV	0.90

◉ Speckles were a change similar to the GOES .

> Using the data of a plurality of satellites, we will consider the effects of the surrounding environment .

Summary

- Speckle is an index to measure the inflow of particles.

- Using the data of Hinode / XRT, it was detected Speckle.

- Speckles were a change similar to the GOES above the polar region.

- The energy required to produce the speckle was estimated to 50keV per 1pixcel.

- Go conducted consider plasma flow path and energy.